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ONI 223D

ONI PUBLICATION

RESTRICTED

A small, dark-hulled ship with a single mast and funnel is shown in the lower right, moving towards the left. A thin line, representing a tow cable, extends from the ship towards the upper left, where it connects to a large, stylized explosion or mine burst. The background is a light, textured grey.

MINE WARFARE



PREPARED BY DIVISION OF NAVAL INTELLIGENCE IN COLLABORATION WITH MINE WARFARE SECTION, BASE MAINTENANCE DIVISION

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ONI 223-D — MINE WARFARE

NAVY DEPARTMENT
Office of the Chief of Naval Operations
Washington, D. C.
March, 1944

1. This pamphlet has been prepared for the purpose of familiarizing personnel in the field with the ships, equipment, and methods employed in modern mining and minesweeping operations. The types of mines, mine fields, minelayers, and minesweepers used in mining and sweeping operations have been illustrated with a view to providing a background for accurate observation of enemy mine warfare activities and for analysis of reports and reconnaissance photographs.

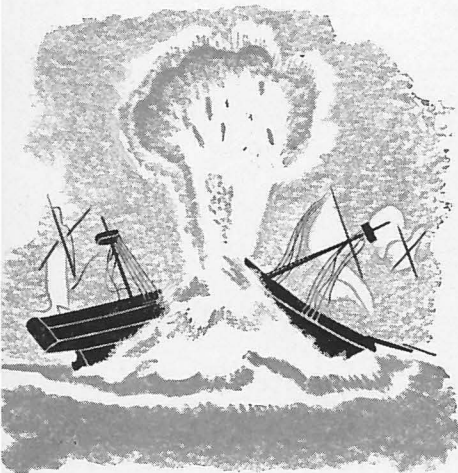
2. Aerial observers, photographic interpreters, and briefing officers will

find this pamphlet especially useful.

3. ONI 223-D has been prepared by the Division of Naval Intelligence in collaboration with the Mine Warfare Section of the Base Maintenance Division at the request of the latter activity. Subject to limitations implicit in a restricted classification, commanding officers may give this publication such circulation as to insure familiarity on the part of cognizant personnel under their command with mining and mine-sweeping methods.

R. E. SCHUIRMANN,
Rear Admiral, U. S. N.
Director of Naval Intelligence

HISTORY AND EFFECT

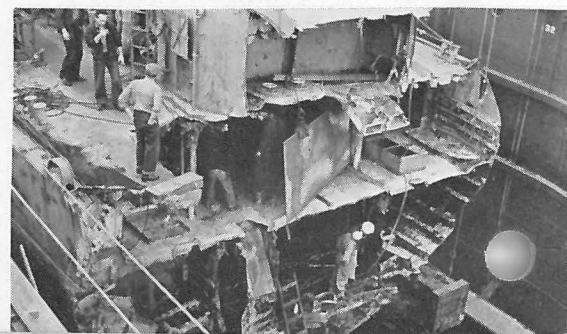


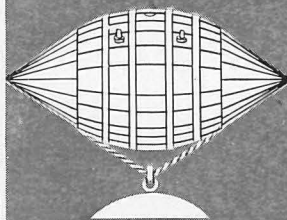
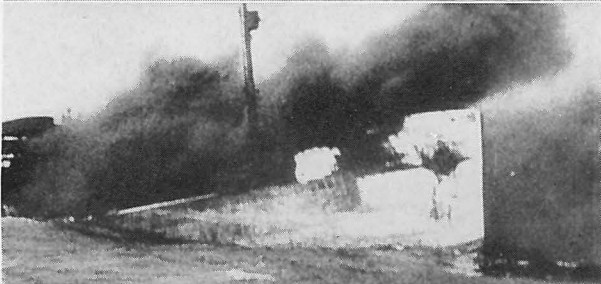
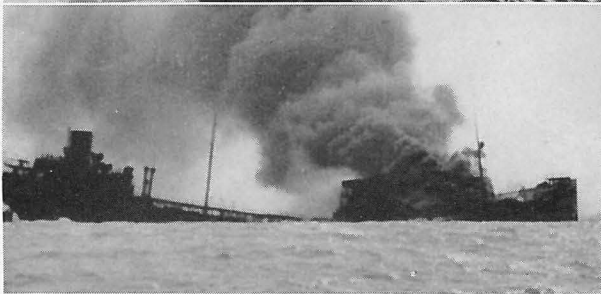
The mine is an old weapon. The Dutch eliminated 800 Spaniards at Antwerp in 1585 with an "explosion vessel," which was nothing more than gunpowder piled in a boat and ignited by a clockwork-operated flintlock. The English experimented with mines for a long time, but cautiously, as they had the biggest navy, and would be the chief sufferers if anything came of the idea. Their caution proved well founded, for it was against the British Navy that the first real mine was used. David Bushnell, the American famous for his midget sub, the "Turtle," resorted to mines when the submarine failed. In 1777, he attempted to break the British Blockade of the Connecticut and Delaware Rivers with floating kegs filled with explosive. His plan was to allow the mines to drift downstream with the ebbing tide, in the hope that they would be detonated by contact with the blockading ships. It was an ingenious idea, but beyond panicking the British troops into wild firing at the unseen foe (the "Battle of the Kegs"), the mines did no major damage.

Robert Fulton, who had his hand in almost everything from steamboating to portrait painting also dabbled with mines. After several false starts, he persuaded the British to let him try an underwater charge against a ship, and much to the surprise of everyone but Fulton, the brig "went to pieces like a shattered eggshell." No further use was made of the idea at this time.

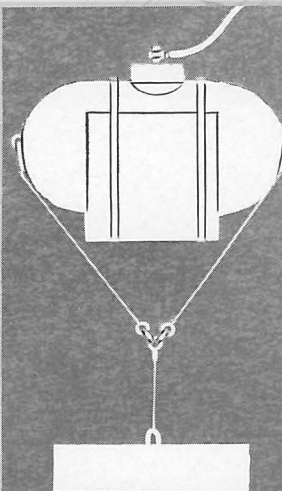
The mine graduated from the gadget stage in the Crimean War, and by the time of the War Between the States it was a full fledged weapon. Three times as many Union Ships were sunk by mines as by Confederate gunfire. Admiral Farragut damned his way into Mobile Bay in spite of the mines. Forty years later in the Russo-Japanese war, losses of heavy warships from mines were divided between the belligerents, the Japs losing eight and the Russians four. With World War I the mine really came into its own. Almost 250,000 were laid during the period of hostilities, and sinkings were on an enormous scale. In addition to actual losses inflicted on general shipping, the threat of the North Sea Mine Barrage may have been a powerful factor in the eventual mutiny of the High Seas Fleet.

The mine is playing a deadly role today. Thousands of mines have been laid, hundreds of ships have been sunk, and further hundreds have limped back into port with gaping wounds, ample testimony to the deadliness of the old sea mine.

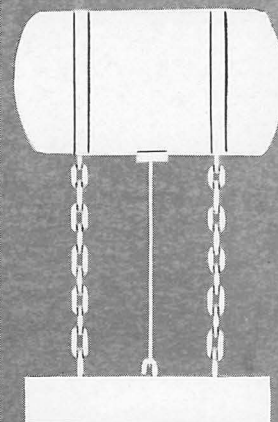




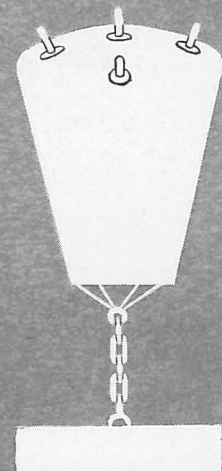
*Bushnell's
keg mine-1777*



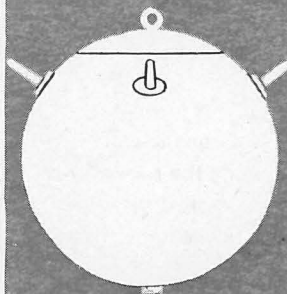
*first moored mine
1810*



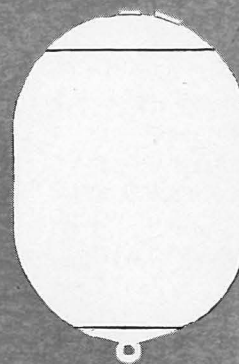
*Confederate
harbor mine-1864*



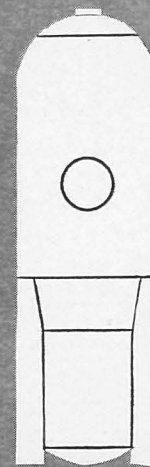
*Crimean
horn mine-1855*



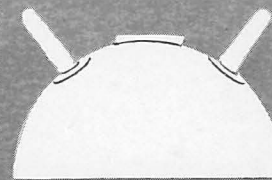
World War I mine



*World War 2
magnetic mine*



modern mine bomb



*Japanese anti
landing craft mine*

WHERE IS THE MINE?

GROUND

Naval Ground Mines—The ground mine is so called because it rests on the sea bottom. Its unfamiliar cylinder shape is almost entirely a development of World War II. Laid by aircraft, surface ship, or submarine, the ground mine is limited in its usefulness only by the fact that it cannot be laid effectively in very deep waters. The weight of the mine prevents it from rising to the surface or rolling about.

DRIFTING

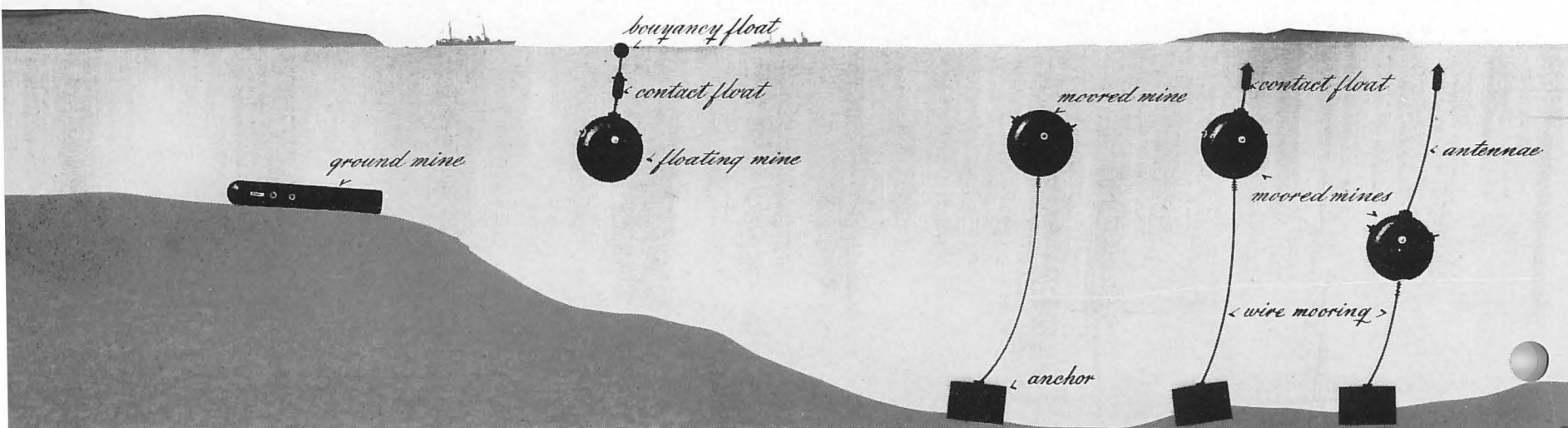
Naval Drifting Mines—This classification includes any mine which is not attached to or in contact with the sea bottom. It is a tactical mine mainly used for dropping ahead of enemy ships. By international law, such a mine must be designed to destroy itself or become harmless within a certain time after the time of laying. This provision is to protect neutral shipping, and, of course, protects our own ships as well.

MOORED

Naval Moored Mines—The moored mine is a buoyant case attached by cable or chain to an anchor resting on the ocean floor. It may have additional contact floats or antennae to increase the danger range. Although primarily a defensive mine, a redesign for laying by submarine and aircraft has extended its over-all usefulness to include offensive fields in deep enemy waters. The moored mine is the old popular favorite, appearing in moving pictures and comic strips.

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BY

BY



HOW IS THE MINE FIRED?

BY CONTACT

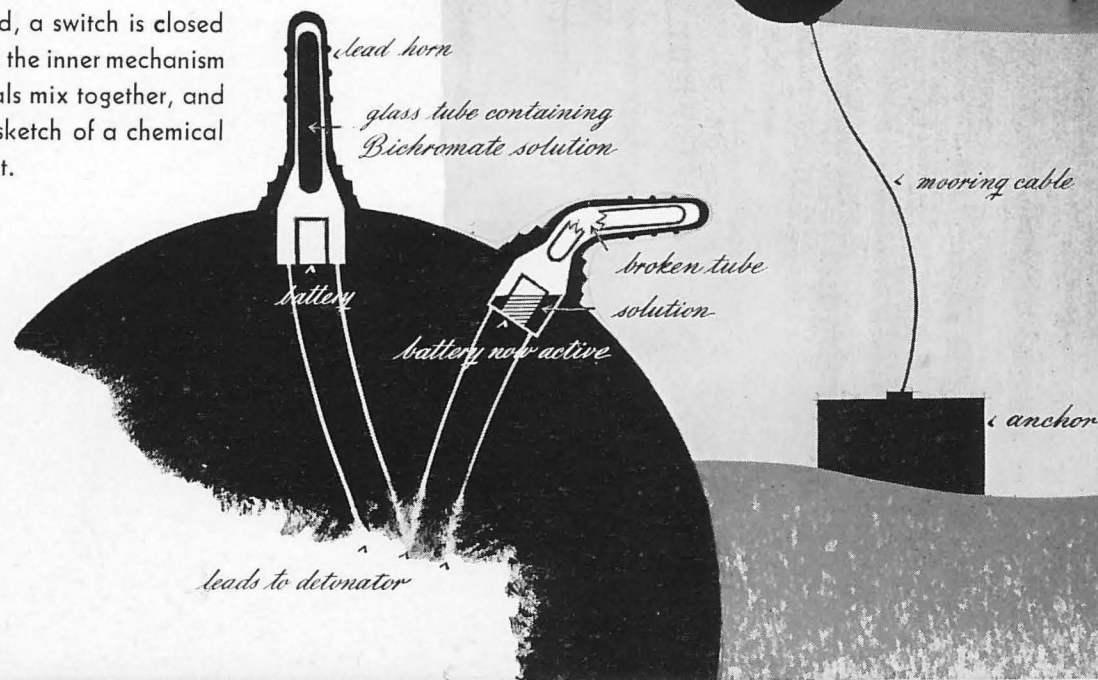
The popular mental picture of a mine is a round iron ball bristling with protruding horns. Except for the tendency to overpopulate with horns, this picture is correct—for contact mines. A ship must come in physical contact with this type of mine in order to fire it, hence the name.

If a contact type of firing mechanism is to be used, the mine must float on or near the surface, in an area through which the ships may normally be expected to pass. Moored and drifting mines are very often contact fired; ground mines, almost never.

The distinctive horns of a contact mine can be either electrically or chemically operated. When the metal horn comes in contact with a vessel it is bent out of its original shape. If it is electrically connected, a switch is closed or a sea circuit completed, exploding the mine. When the inner mechanism of a chemical horn is crushed by bending, the chemicals mix together, and the firing circuit is closed and detonation results. A sketch of a chemical horn, before and after contact, appears to the right.

BY CONTROL

A controlled mine is one whose firing mechanism is operated from a distance. Fields consisting of controlled mines are used to deny entrance of enemy ships to harbors where friendly traffic must be free to pass. A controlled mine field may consist of mines laid in a harbor with connections by cable to a shore station. A station operator is warned when an enemy ship is over the field and switches the mine so that it will detonate under the intruding vessel.



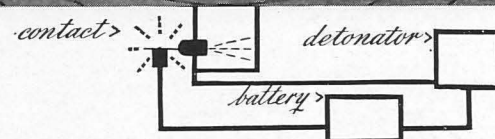
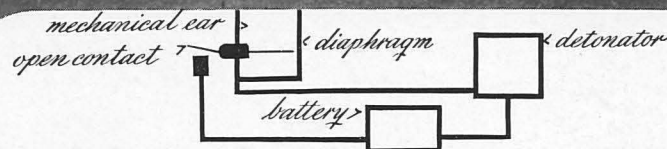
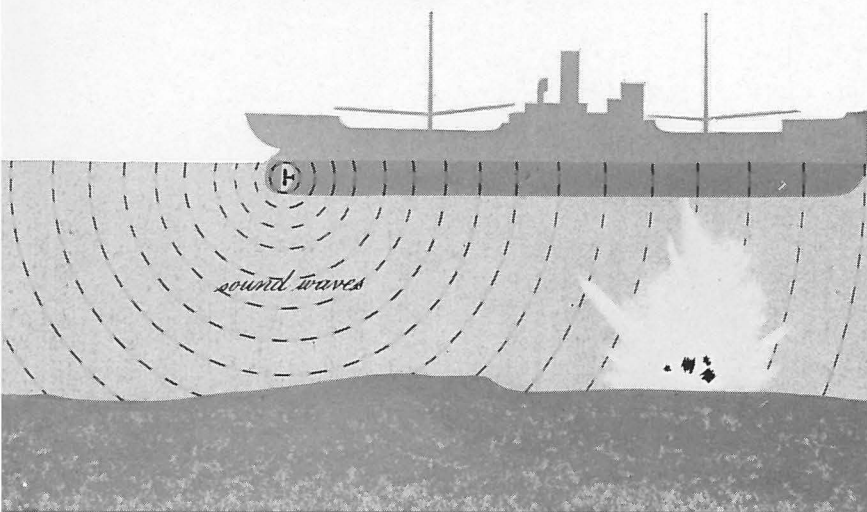
HOW IS THE MINE FIRED?

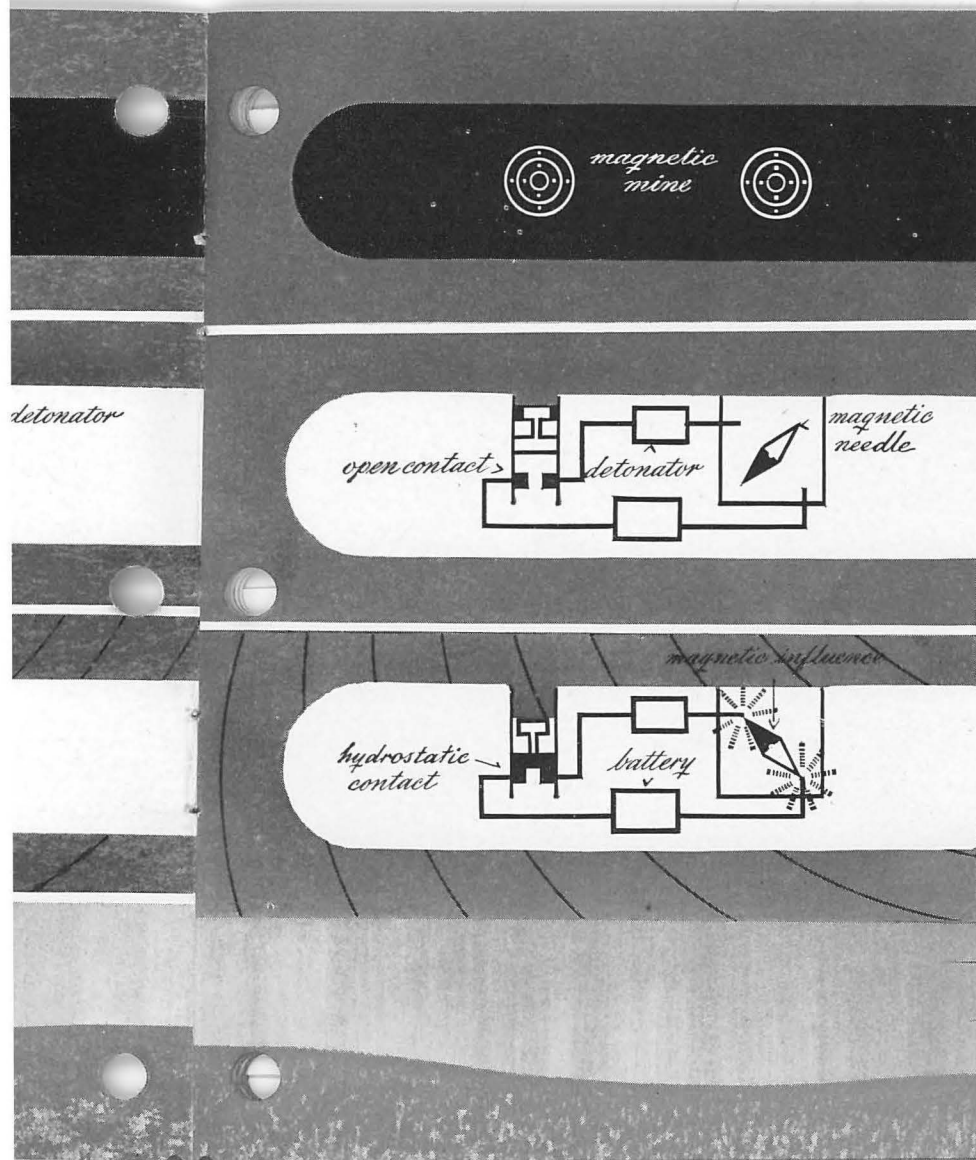
BY ACOUSTIC INFLUENCE

The newest type of firing mechanism does not require actual contact between mine and ship, but only the presence of a vessel near the mine. For this reason, mines so detonated are known as influence (as opposed to contact) mines.

Two means through which a ship's presence is translated into firing influence are: (1) The sound created by the ship's screw or engines, and (2) Reaction to the magnetic field of the vessel.

The pounding of a ship's engines, the churning of the screws, and disturbance of the water along her hull create a considerable underwater din. This noise travels great distances through the water. In Acoustic Mines, a mechanical ear installed in the mine case will react to these waves, and when a ship has approached close enough for the sound to be very loud, the ear closes a contact and fires the mine. The diaphragm in a telephone is an example of the principle. The sketch below shows how the noise of the propellers fans out in waves and acts upon an Acoustic Mine on the ocean floor. No means have yet been found to neutralize the sound of a vessel's passage through the water.

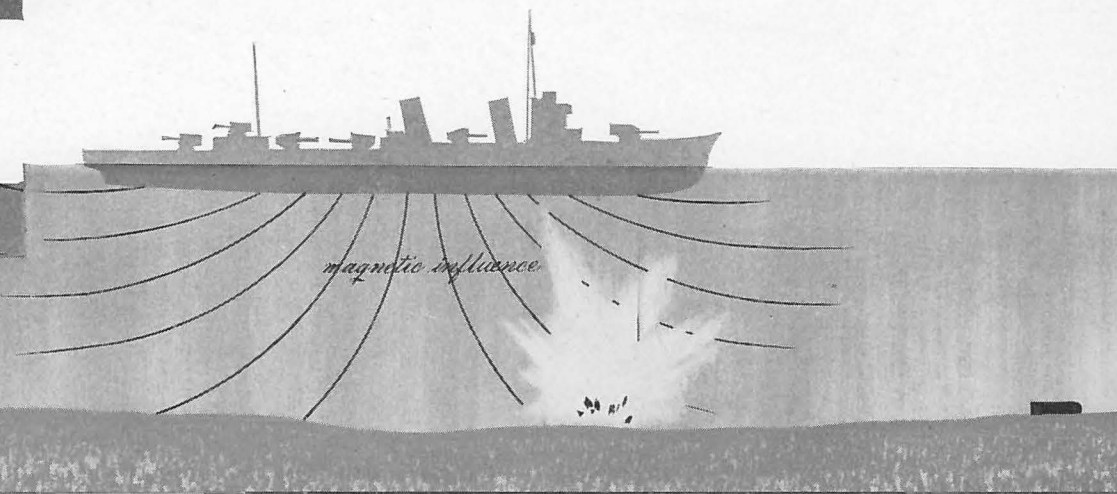




BY MAGNETIC INFLUENCE

The Magnetic Mine was one of Hitler's first secret weapons. Although the American and British services had experimented with it, the Germans were the first to put the device to use. Its operation is explained in the accompanying sketches.

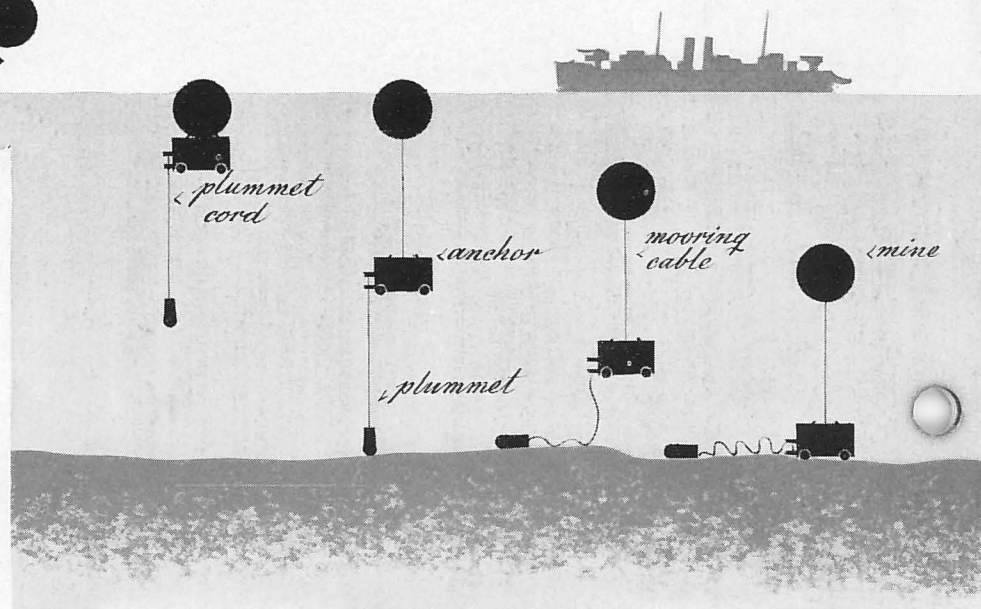
The iron ship is magnetized by the same magnetic field of the Earth that controls the compass needle. The Earth's field acts upon the vessel and makes it a huge magnet, which in turn puts out its own highly concentrated field, as shown schematically by concentric circles in the sketch below. The mine contains a magnetic needle which is very similar to that in a compass. The enormous magnetism of the ship is sufficient to turn the mine needle on its pivot. It is an easy matter to have this turning needle close an electrical circuit and fire the mine. In order to protect the minelaying aircraft in flight, a gap in the electrical circuit is kept open until closed by water pressure acting upon a hydrostatic plunger. The magnetic mechanism may be installed in either the ground mine or the moored mine cases.



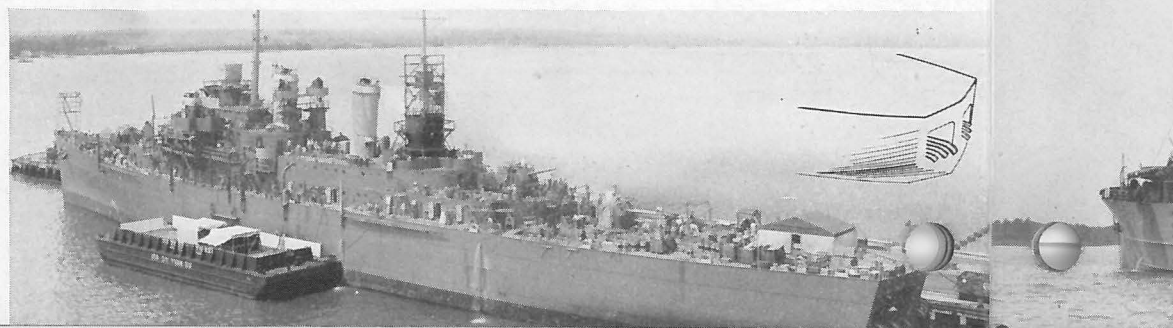
DEFENSIVE MINELAYERS—CM's

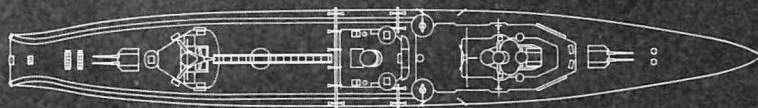
The CM's are the biggest minelayers of all, carrying large loads and capable of traveling long distances. They are usually limited to laying defensive fields for the protection of our own harbors. Some of these vessels are specially built for their jobs; for example, the U. S. S. *TERROR*, one of our newest minelayers. Others are converted cargo ships and train ferries. Whether old or new, the large minelayers have one distinctive feature; their broad flat sterns. This stern may be provided with exposed rails along which the mines roll until dropped into the sea.

When the typical moored mine is launched, it floats case upright on the surface. After a short interval the plummet is released and runs out on a pre-set length of plummet cord. This length is the distance below the surface at which the mine case will eventually float. When the plummet cord has run out, the anchor separates from the mine case and starts to sink, following the plummet down, but leaving the case on the surface. Eventually the plummet strikes the sea bottom, and the release of tension on the plummet cord locks the mooring cable drum, preventing the cable from further unreeling. Naturally the anchor continues to sink, but now it drags the mine case down from the surface. It may be seen from the sketches that the eventual depth of the mine case is equal to the length of the plummet cord.



▼ USS *Terror*, Modern CM





▼ U. S. Merchant Conversion

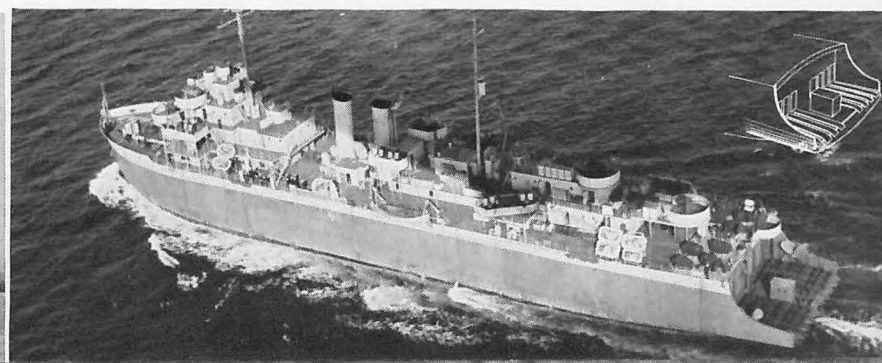
▲ Recco Photo, Okinoshima Class CM



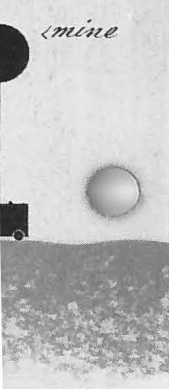
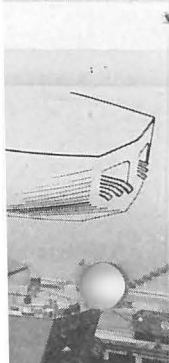
▲ Modern Japanese CM



▲ Okinoshima Class



▼ USS Keokuk

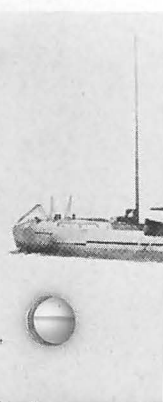
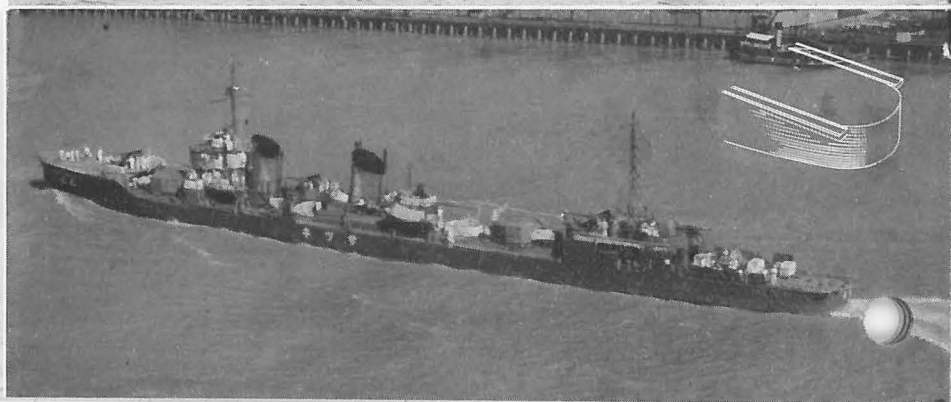


MINELAYERS

OFFENSIVE DM's, PT's

Secret Minelaying by ship in enemy waters is the job of fast destroyer minelayers, motor torpedo boats, or submarines. The DM has speed enough to make a quick dash under cover of darkness, lay its mines, and get away before being discovered. The mines are stowed on deck, usually on two parallel sets of rails, one on either side. Naturally, the capacity is limited, an average DM holding under 100 mines. The mines carried are usually of the moored variety, but it would be perfectly possible for a DM to lay drifting mines in the path of an enemy fleet. Most U. S. destroyer minelayers are converted from flush-deck destroyers. These ships, are however, often used for many of their old duties after conversion to minelayers.

The motor torpedo boat and the German E-Boat, have done a lot of minelaying in the present war. Although limited in capacity, the PT has exceptional speed and is capable of maneuvering in shallow water right under the nose of enemy beach defenses. The mines are rolled over the side from racks.



S'

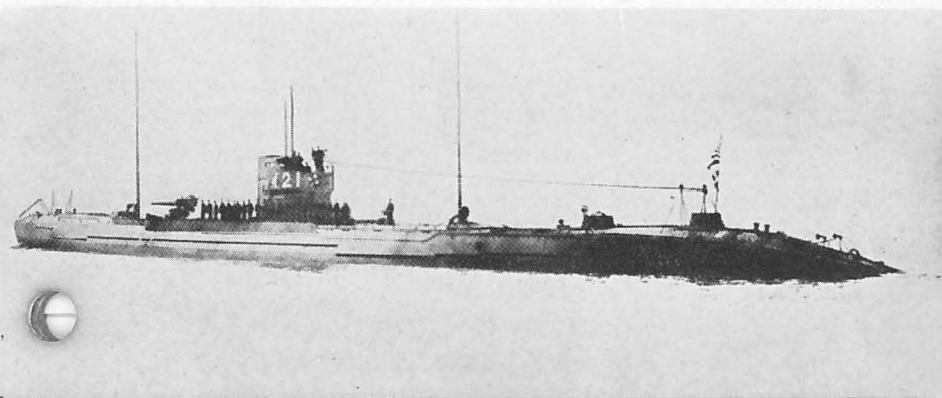
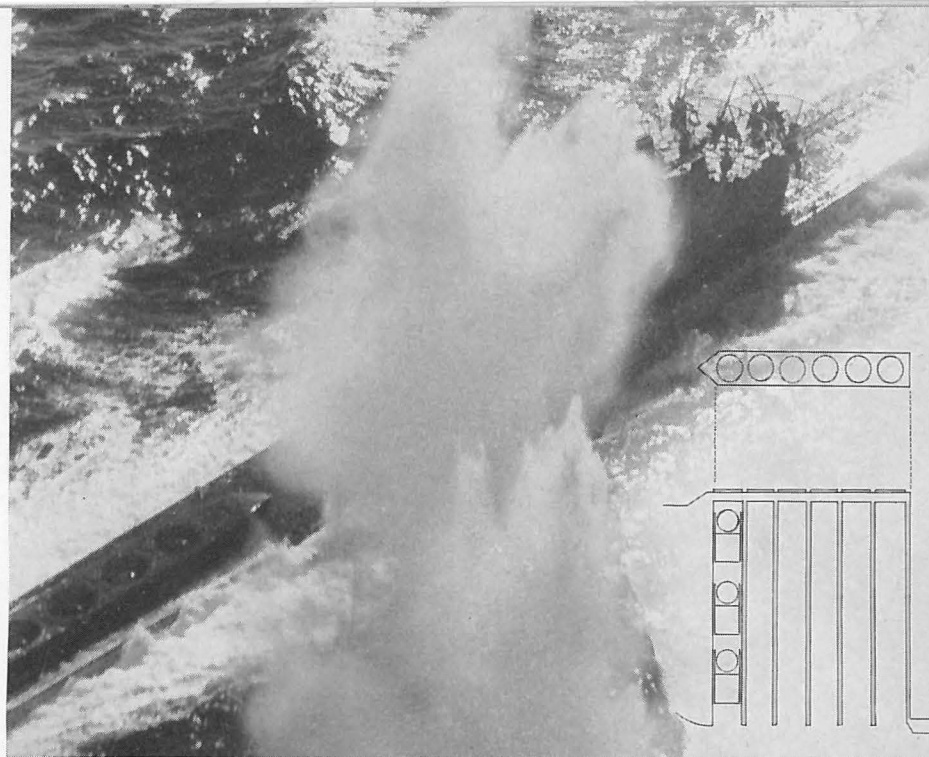
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SUBMARINES

The minelayer capable of the highest degree of operational secrecy is the submarine. What it lacks in speed is made up for in extended range and submersibility. The SM may proceed to areas well within the enemy defenses, and lay mines where they are most effective. It can lie unobserved for days while spotting ship traffic, then move in to plant mines with a maximum chance of disrupting shipping.

The submarines of the present war lay their mines from deck tracks, from torpedo tubes, or from special mine tubes built vertically or horizontally into the hull. The photographs to the right show a German minelaying submarine under air attack. Six vertical tubes are clearly visible on the deck near the bow. These photographs were most helpful for intelligence purposes. Naturally, the SM has a limited capacity, generally not more than 75 mines. What it loses in this respect is more than made up for by its range and the secrecy of its operations. Directly below is a Japanese type.



MINELAYERS

plane



AIRCRAFT

Minelaying by aircraft is a new development of World War II. Germany attempted early in the war to block off the British Isles by aircraft-laid mines, but failed due to the British ingenuity in developing counter measures. Planes loaded with mines may penetrate far into enemy areas, planting fields in inland waters, landlocked harbors, or across well-guarded shipping lanes. Almost any aircraft capable of carrying bombs or torpedoes is adaptable for minelaying. The number of mines carried will vary with aircraft type, but is roughly the same as for standard Army-Navy bombs or torpedoes.

Aircraft-laid mines are usually of the Ground Influence type, dropped with or without parachutes. Mines with parachutes or drogues are capable of being laid from high altitudes, as the chute will slow descent and protect the mines' inner mechanism. However, the use of parachutes results in a slight loss of accuracy in planting. Chuteless mines must be laid from lower altitudes. Laying of such mines is less apt to be observed by minewatchers on shore.

parachute releases

mine

parachute sinks

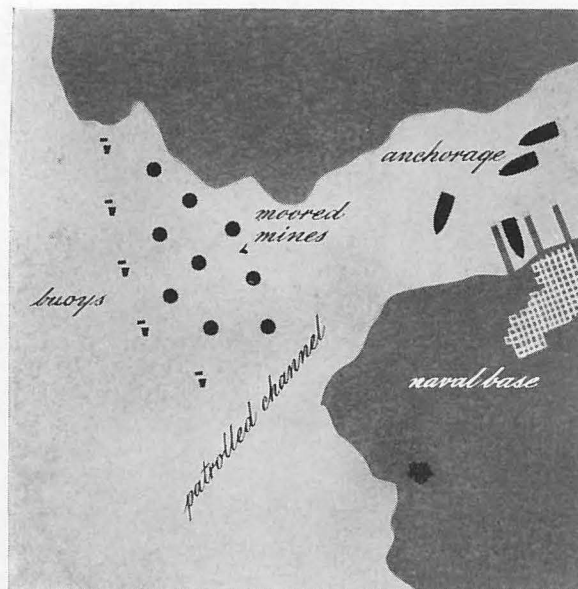
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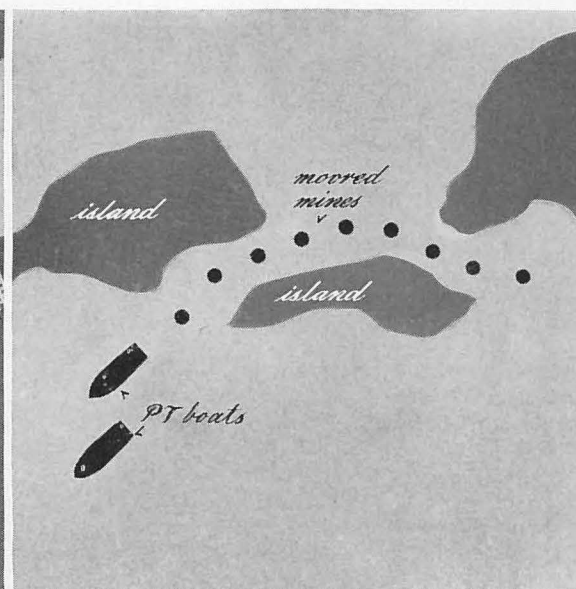
DEFENSIVE FIELDS

Large CM's lay defensive fields. Major harbors, river mouths, coastal shipping lanes, and sea anchorages are a few of the potential locations. Secrecy is of secondary importance to the safety of friendly shipping, and the defensive field is usually well buoyed and publicized. Gaps in the field for ship passage are patrolled or guarded by sea nets or various detecting devices. Openings in a defensive field may be protected by controlled mines.



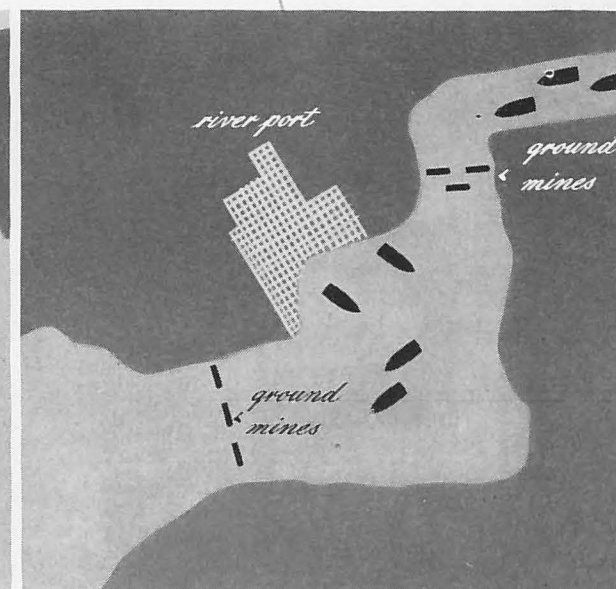
SHIP LAID OFFENSIVE FIELDS

Fast minelayers and submarines are used for laying offensive fields in enemy waters. Bottlenecks in shipping lanes such as the passage between islands are favorite locations. Points of shipping concentration outside enemy harbors are often well marked and confusion and losses may result when they are mined. Convoy routes are particularly vulnerable to minefields planted by these fast and secret minelayers.



AIRCRAFT LAID OFFENSIVE FIELD

Waters inaccessible to surface layers are readily mined by aircraft. Potential areas include anchorages upstream from a river mouth, landlocked bays, inland waterways, or closely protected coastal shipping lanes. These waters may be effectively blocked by aircraft laid mines. An aircraft may replenish a minefield without danger to itself from mines remaining from an earlier lay—a danger always present with surface layers.



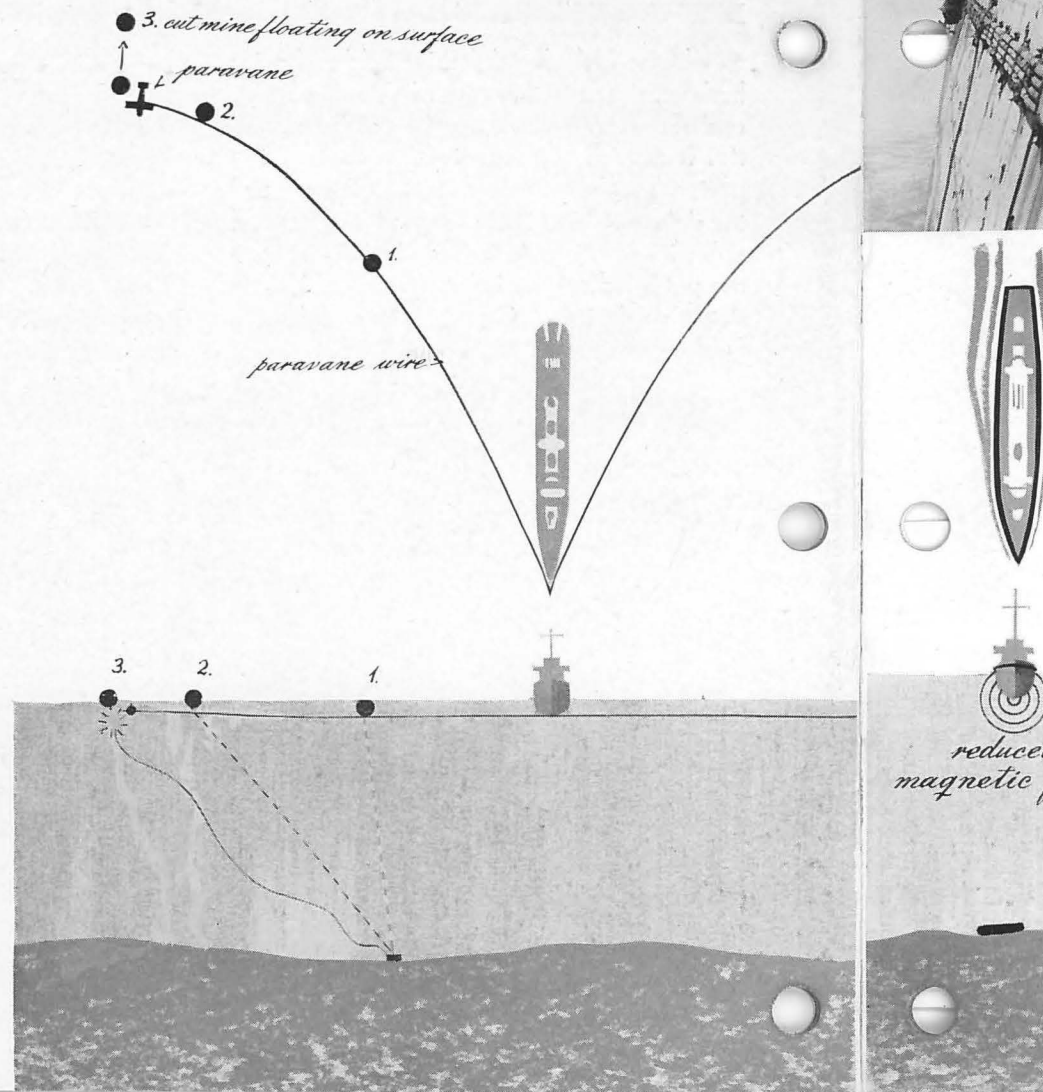
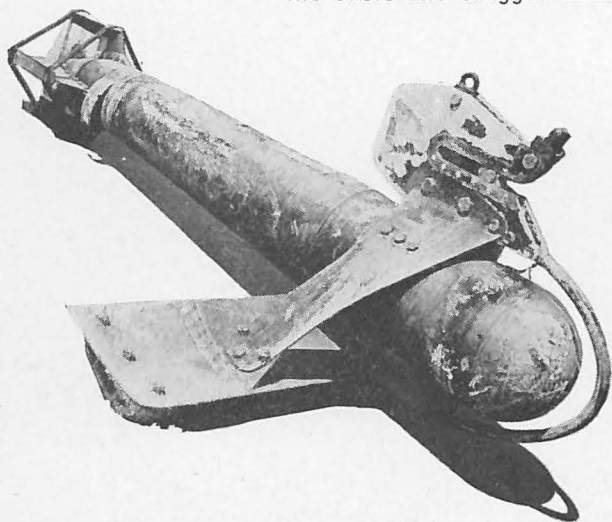
SELF-PROTECTION BY SHIPS

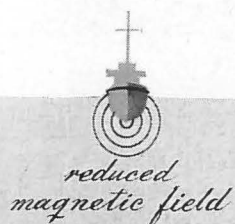
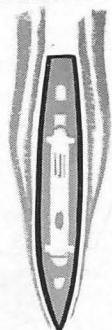
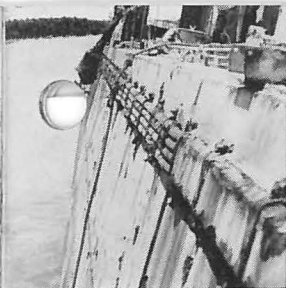
PARAVANES VS. MOORED MINES

A measure of self-protection for ships against moored mines may be given by streaming paravanes from the bow of the vessel.

A paravane is launched at one end of a wire cable, the other end of which is fixed aboard ship. When the vessel picks up speed, the paravane takes up a predetermined depth and streams out to the side, thereby stretching the cable taut. The bow wave of a moving ship usually deflects the moored mine away from the bow. Normally, the mine would swing back in against the ship's side, but with a pair of paravanes streamed, the mine is caught by the cable and dragged along it to the paravane. At the

paravane the mine mooring is severed by a cutter. The picture to the left is of a United States paravane, and clearly shows the cutter on top of the float. The sketch to the right illustrates the progressive steps in the catching of a mine by a bow paravane.





DEGAUSSING vs. MAGNETIC MINES

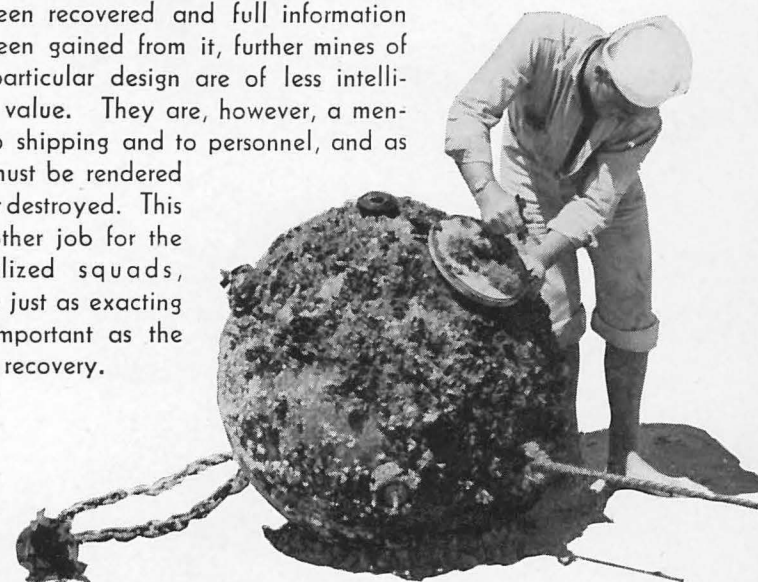
Ships may be protected against some magnetic mines by a process known as "degaussing." A magnetic mine is actuated by the magnetic field of a ship, and if this field can be sufficiently neutralized, the vessel may pass over the mine without actuating it. Degaussing protection is effected by application of one of the basic laws of physics. If an electrical current is passed through a wire, a magnetic field is set up around the wire. British engineers, faced with the problem of the German magnetic mine, soon decided upon the use of this principle as a means of protecting ships. They wrapped horizontal coils of wire completely around the ships at about main deck level. Strong electrical currents passing through this wire loop set up a magnetic field which is in opposite direction to the ship's field. The total magnetic influence of the ship is thereby reduced. The wire loops are given the name of "degaussing coils."

The picture shown is of a Japanese warship whose degaussing coils may be clearly seen, girdling the hulls at about main deck level. More modern installations are designed with the coils placed inside the hull of the ship, where they are protected against damage due to ship contact or sea action. This redesign has also made it possible to place the coils at approximately water level where they are more effective.

RECOVERY

There are two main sources of information on enemy mine warfare. One is photo reconnaissance, which reveals enemy mine laying and mine sweeping practices in action. Everything on or above the surface of the water may be photographed and analyzed. Enemy mines recovered by mine recovery units constitute the other source. Recovery reveals underwater developments, and, used in this capacity, makes a perfect teammate for photo reconnaissance.

Recovery and neutralization of enemy mines is a highly dangerous business. It is also an important one. Information derived from analysis of enemy mines serves as a basis for planning countermeasures. When the first example of a specific type of enemy mine has been recovered and full information has been gained from it, further mines of that particular design are of less intelligence value. They are, however, a menace to shipping and to personnel, and as such must be rendered safe or destroyed. This is another job for the specialized squads, and is just as exacting and important as the initial recovery.





United States—Auk Class
221' o. a. x 32' beam x 10' dr.—18 kts.



Great Britain—Algerine Class
225' o. a. x 35.5' beam x 10' dr.—16.5 kts.



Japan—AM 1-6
235' o. a. x 26' beam x 7.5' dr.—20 kts.



Germany—AM 27-66
216.5' o. a. x 27' beam x 6' dr.—17 kts.

▼ U. S. Auk Class

▼ World War I Type U. S.

Converted Destroyer ▼

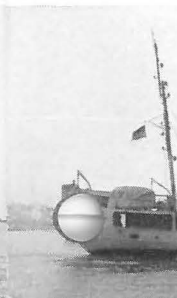
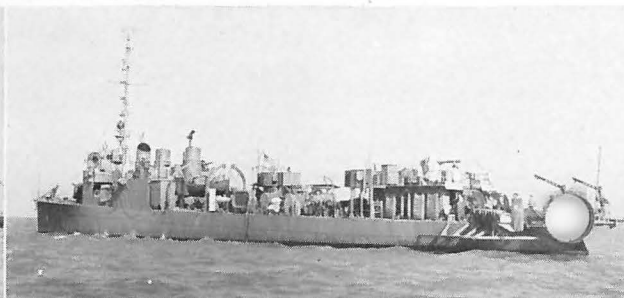
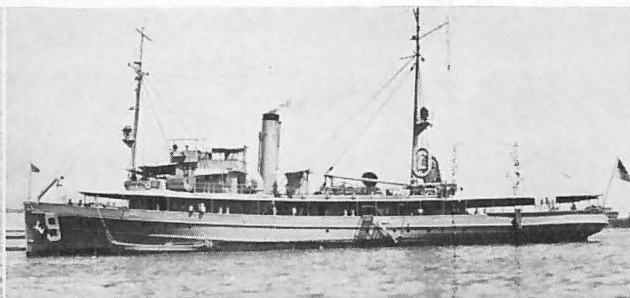
▲ U. S. Auk Class

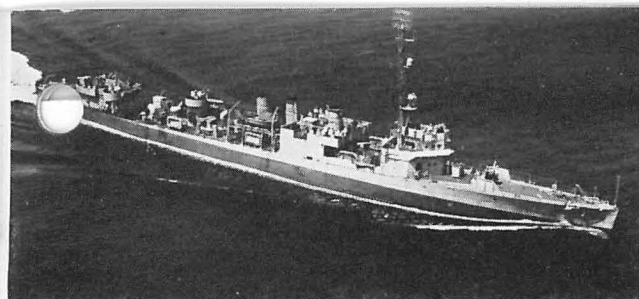
▲ Jap Al

FLEET SWEEPERS

Minelaying and minesweeping are the Castor and Pollux of mine warfare. Wherever one goes, the other follows. The vast increase in minelaying has brought a parallel growth in minesweeping.

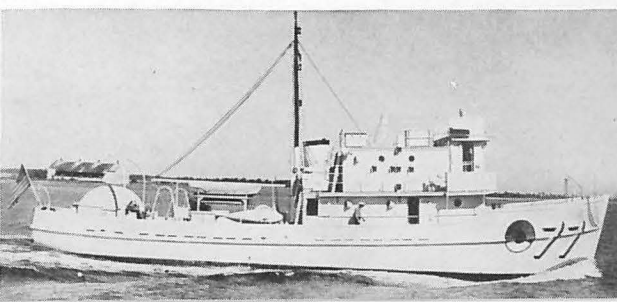
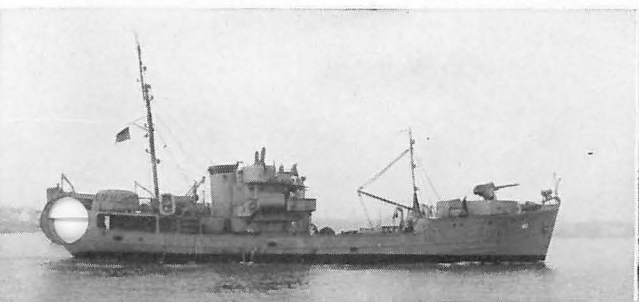
The largest minesweeping craft are the fleet sweepers. For clearing ahead of fleet units, a very fast sweeper is required. Destroyers are often converted to DMS's for this role. Most of the great navies of the world also have fleet sweepers designed and built specifically for the job. They are smaller, slower, and more lightly armed than converted destroyers, but well adapted for sweeping ahead of convoys or landing parties. Sturdy, seaworthy ships, they are well equipped for sweeping, and of sufficiently shallow draft to avoid most moored mines. It is interesting to note that four of the world's navies, in designing fleet sweepers for this purpose produced ships which are very similar in all characteristics, as will be seen by reference to the profiles and measurements at the left. Presence of minesweeping gear aft, with its paravanes, cable reels, floats, and cranes for handling the heavy equipment, is characteristic of the AM's as well as of the DM's.





SMALLER SWEEPERS

The greater part of minesweeping is done by small sweepers. Their job is to keep channels and shipping lanes free of mines and they carry out routine sweeps, day in, day out, regardless of how many mines the enemy may lay. In designing ships for this job, endurance and seaworthiness must be given primary consideration. The sturdy trawlers used for deep-sea fishing are ideally adapted to this type of sweeping and are widely used. Ships especially designed for this coastal work often follow trawler lines. The U. S. Navy's YMS is equipped to sweep both moored and ground mines, with contact, magnetic, or acoustic firing mechanisms. In addition, it has been given sufficient speed and armament to serve as a coastal escort. Duty aboard a ship of this class is likely to be many sided and exciting.



uk Class

▲ Jap AM's

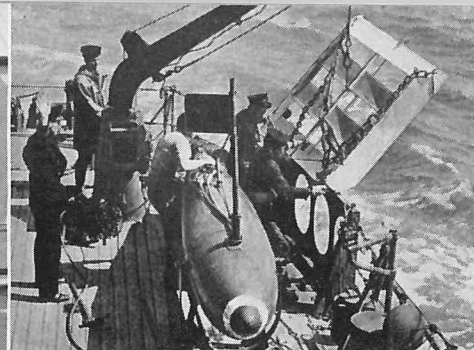
▼ U. S. ex. Trawler

Smaller U. S. Types▶

MOORED SWEEPING GEAR



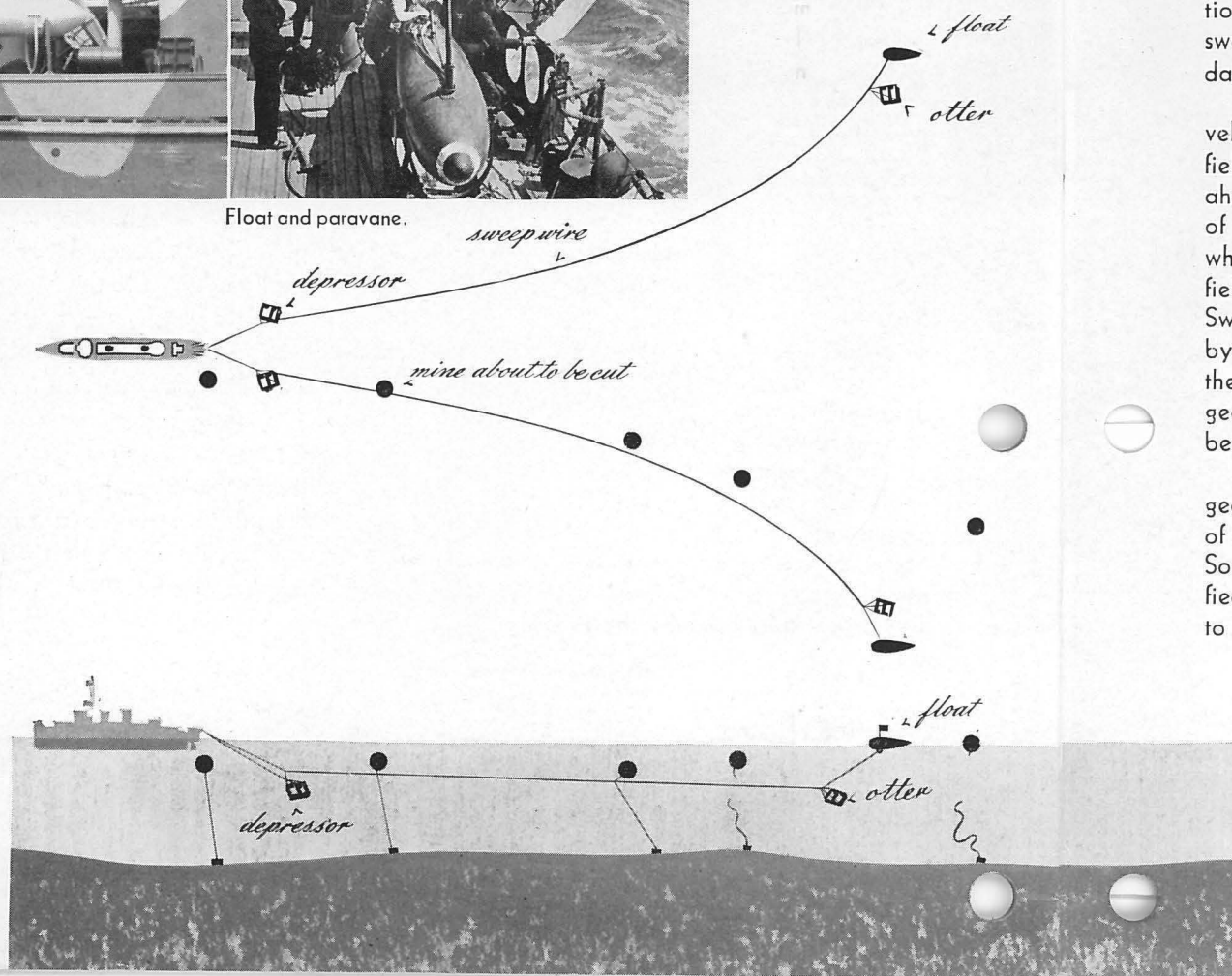
Note depressors at stern, paravanes on "A" frames and white floats.



Float and paravane.

The best way to sweep a moored mine is to cut the mooring cable between the anchor and the case, and then destroy the floating case by gunfire. Moored sweeping gear usually consists of a cable armed with wire cutters, all of which is submerged by devices known as "depressors." Depressors take the cable to a depth below the level of the mine case, so that the cutters may operate on the mooring wire. The sweeping cable may be strung between two ships which operate in line abreast, or may be streamed from a single vessel. If the latter method is used, vane "otters" are employed to take the cable out on the sweeper's quarter so that it will form a loop. Otters are marked by floats with flags or lights.

In the picture, above left, the depressor, otter, and float may all be seen stowed on the deck of a YMS. The second picture shows the gear in preparation for streaming, this time aboard a British sweeper. Great care must be taken to avoid snagging the otter and float with their respective chains and wires. When the gear has been streamed the only part visible above the surface is the float, which appears to be operating under its own power trailing a sizeable wake.

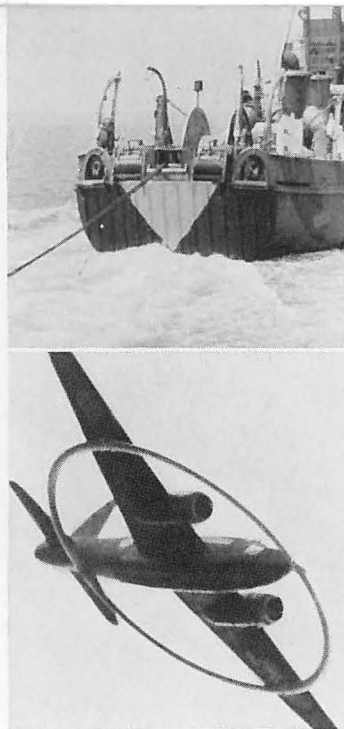


MAGNETIC SWEEPING GEAR

Magnetic mines respond to the magnetic field of the ship. Mines of this type are swept by creation of a magnetic field at a distance from the sweeper. The mine is thus detonated without damaging the sweeping vessel.

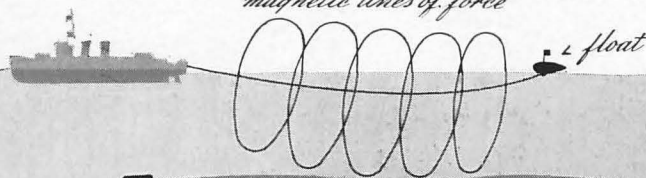
One such means of sweeping consists of development of "magnet" ships, which will produce fields so powerful that mines will be actuated far ahead of the sweeper. Another method consists of towing astern of the sweeper a long wire through which electric current is passed. A large magnetic field is thus created which detonates the mine. Sweepers engaged in this work must be protected by degaussing to permit them to pass safely over the mine, leaving it to be actuated by the sweep gear astern. A coil of wire on a towed barge may be used in restricted waters.

Since most types of magnetic minesweeping gear are floated on the water's surface, operations of this type can easily be detected from the air. Some Japanese magnetic sweeps are easily identified by the wake of a number of small floats used to hold up a nonbuoyant cable.

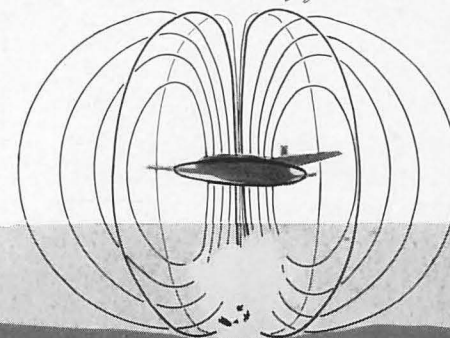


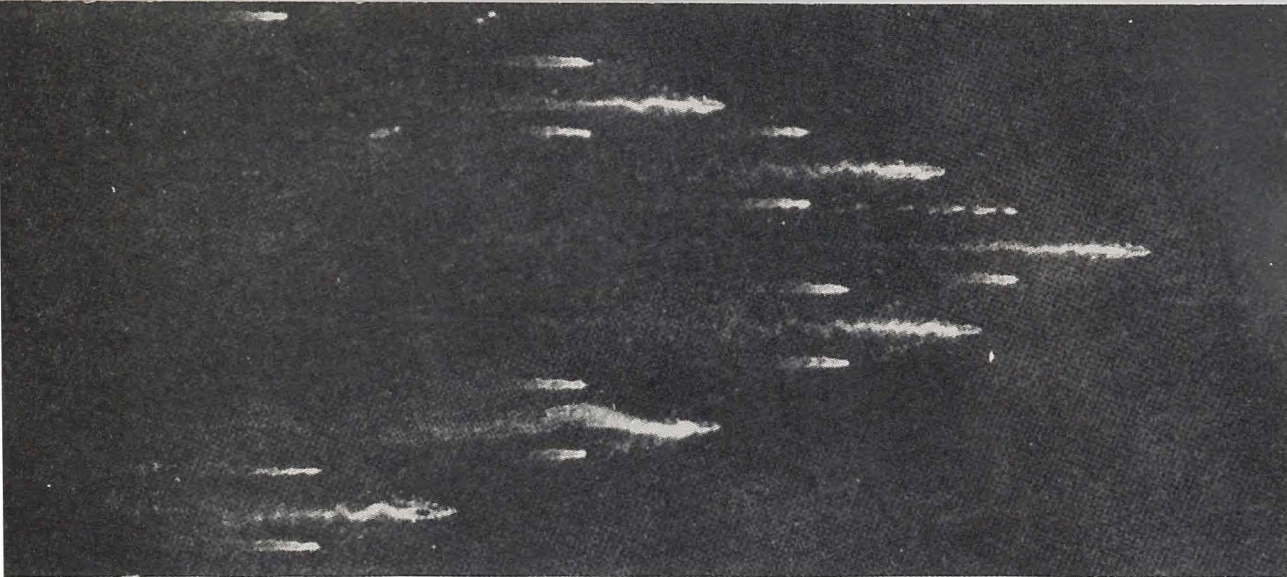
An aircraft adapted for magnetic minesweeping has the obvious advantage of being able to cover large distances with great speed. The aircraft sweep pictured to the left is equipped with a generator for providing electric current to pass through the huge coil carried by the plane. This current sets up an extensive magnetic field which sweeps mines of this type that come within its influence. The field is strongest directly under the coil where the magnetic lines of force are concentrated, as shown in the sketch below. The width of the swept path of such an aircraft is rather limited, but the speed with which rivers and canals may be cleared renders aircraft sweeps admirably suited to this type of work. Certain mines, however, may not be swept or may fire at such a position as to damage the sweeping plane.

magnetic lines of force

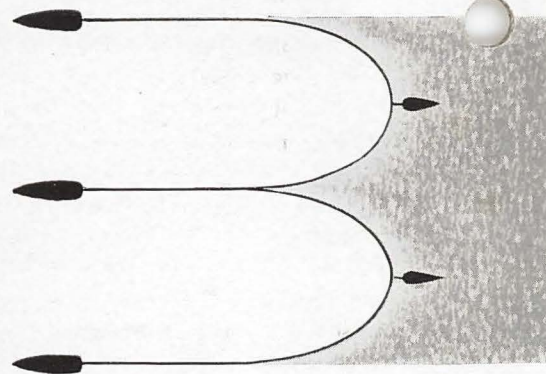


magnetic lines of force



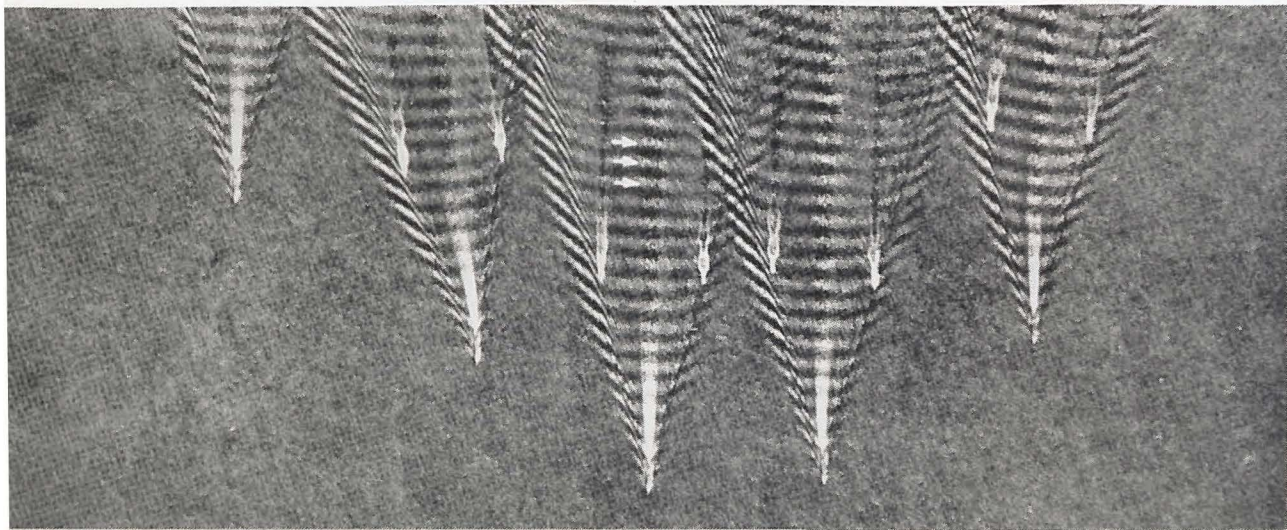


▲ Echelon for mine clearing.



▼ Echelon for mine searching.

▼ Line abreast sweeping formations.



SWEEPING FORMATIONS

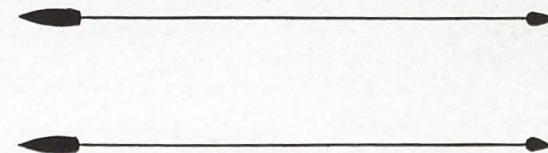
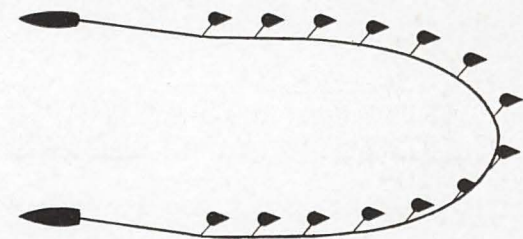
Photo reconnaissance is the major source of our knowledge of enemy minesweeping techniques. A good photograph of sweeping formations may reveal that the enemy can or cannot sweep our mines. Intelligence gained from this source may thus have an important effect on our minelaying program.

The photographs reproduced on these pages are examples of photographic reconnaissance views of sweeping operations. On the left are pictures of moored minesweeping formations. In each instance, the sweeper is followed by one or a pair of floats which reveal themselves by wakes almost as large as those of the towing vessel. Because of the apparent lack of connection between the sweeper and the float, the latter has often been mistaken for a separate ship. Two sweepers with four floats will thus become "six ships," and six ships make a convoy. Bombs away! One instance is known of a plane depth-charging a float because it resembled a periscope.

Moored formations may show the sweepers in echelon, or in line abreast. The drawing on the opposite page is illustrative of ships proceeding abeam, trailing catenaries of wire from sweeper to sweeper. Only the float supporting the center of the wire would show above the surface of the water.

At the right are sketches of magnetic minesweeping formations. In the top picture, a Japanese magnetic sweep is shown, towed by two ships and supported by a large number of floats. In the middle sketch buoyant cables are seen streamed directly astern of towing sweepers. The entire cable may be seen on the surface, as well as the float at the end of the cable, which is used primarily to mark the tail end. The third picture illustrates the towed barge with a coil of wire, for use in limited channels. Usually the result of this sweep is "one mine—one barge."

Sweepers in formation will either be in line abreast or in quarter echelon. They will betray their occupation by the trailing "sweep tails" or by the wakes of the sweeping floats. Photographs of such formations are of great value in mine warfare intelligence.



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